NAWQA Regional Stream Quality Assessments

- Status of the stream quality in the region
- Relations between stressors and ecological condition
- Relations between environmental setting and stream quality

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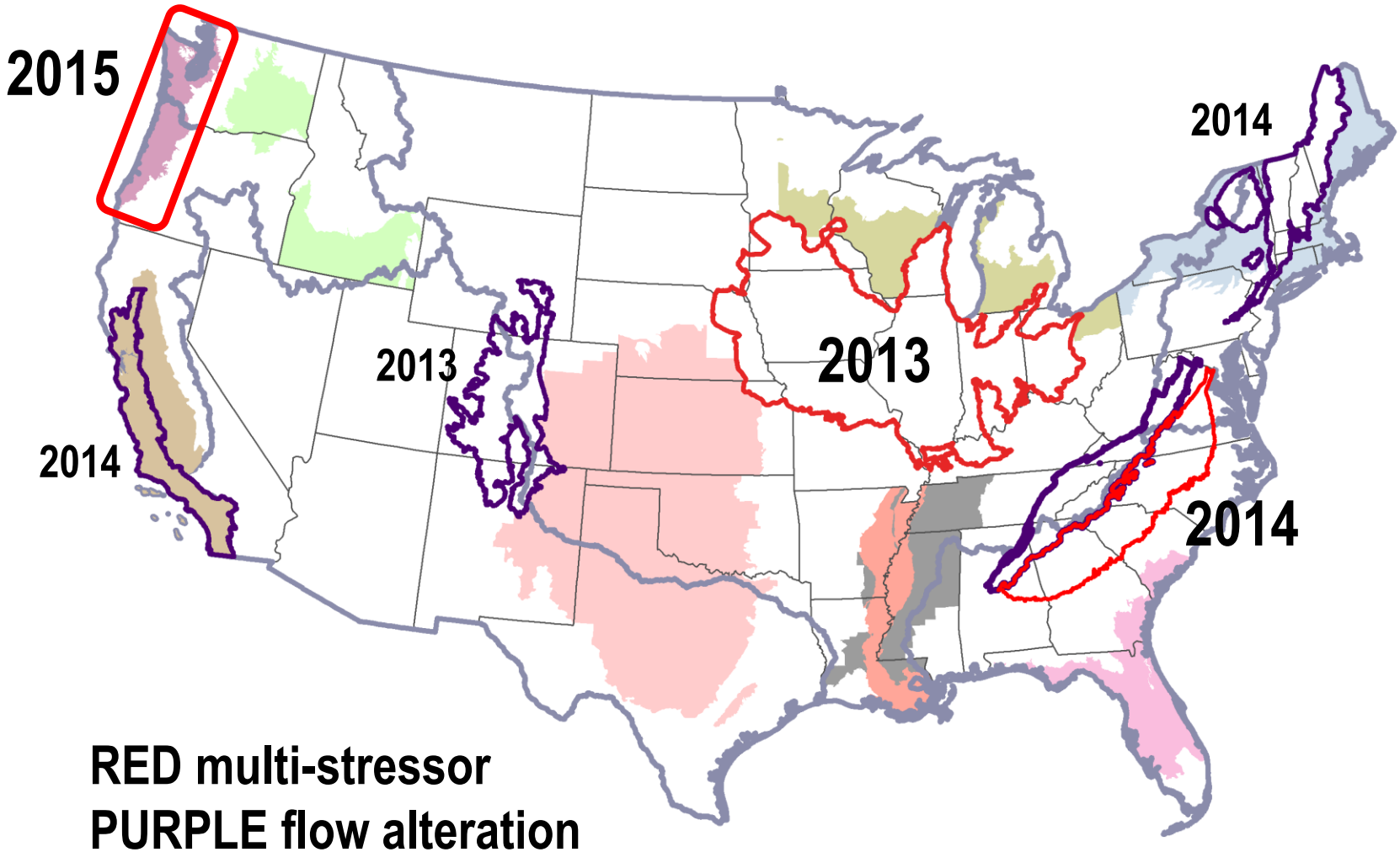
RSQAs as of 2014



RED multi-stressor
PURPLE flow alteration

RSQA components

- Geographic distribution and seasonal changes in stressors
  - Contaminants, nutrients, and sediment in water
  - Contaminants in sediment
  - Contaminants in time-integrating samplers (POCIS)
  - Toxicity of sediment and water
  - Continuous WQ monitoring/temporal benthic chlorophyll
- Ecological conditions
  - Ecological sampling at all sites and regional estimates of condition
- Modeling/prediction

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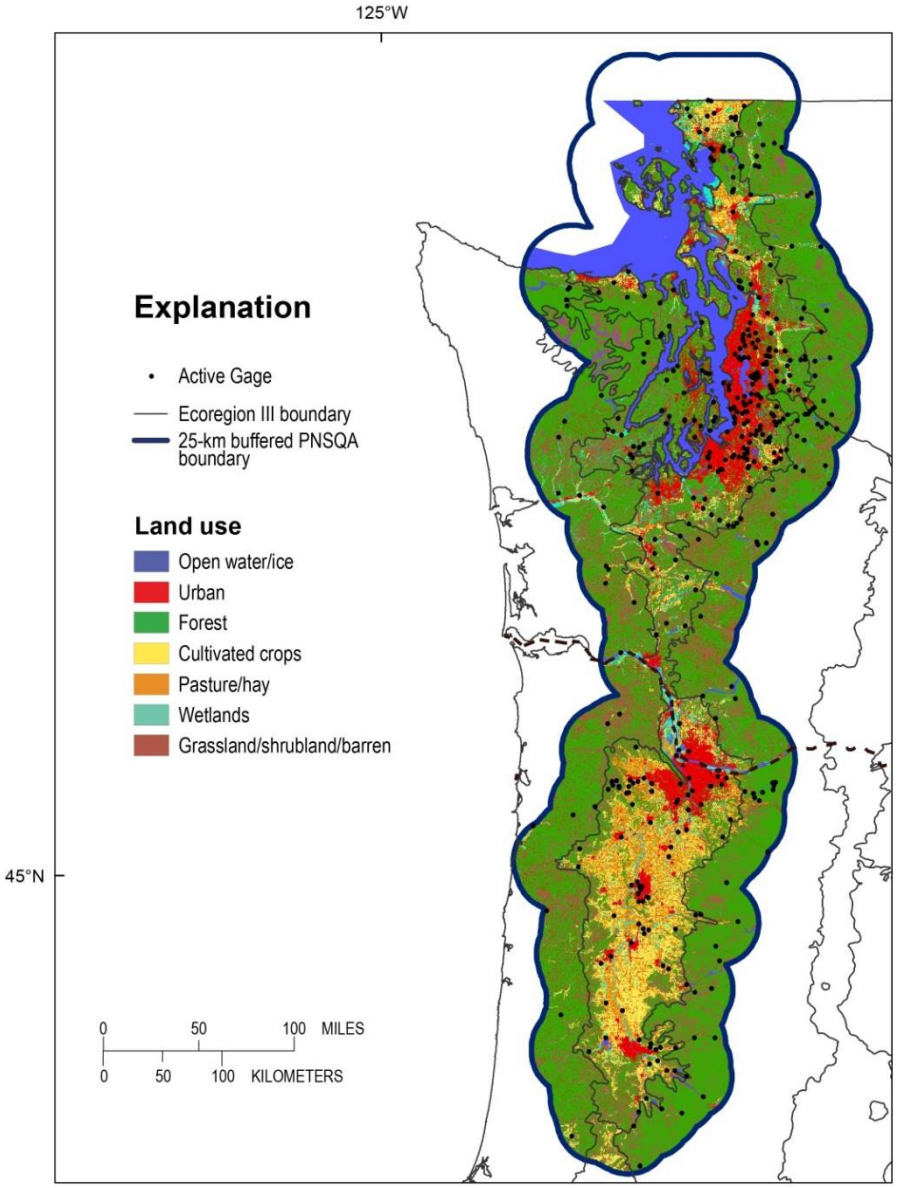
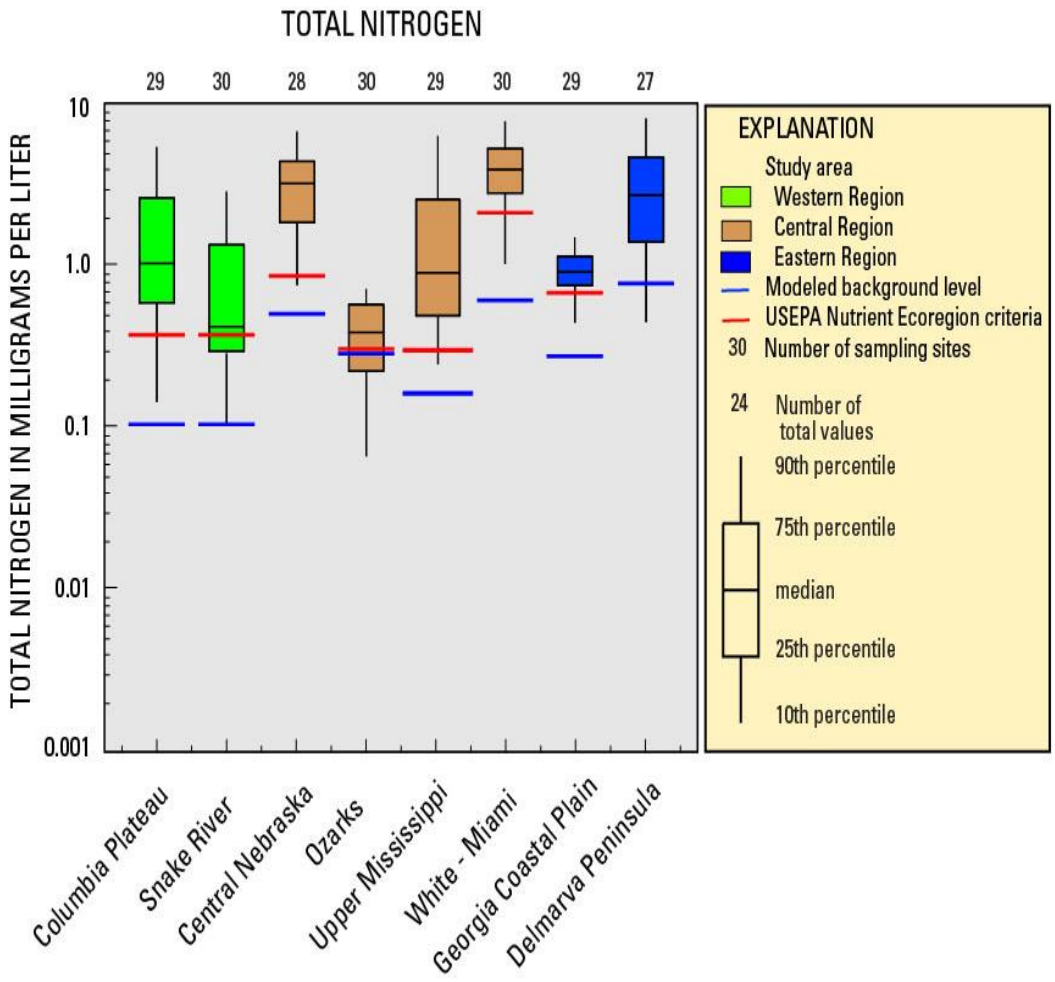
- 88 sites
- April-June weekly chemistry
- Late June ecology/habitat
- Continuous WQ
- Sediment sources
- Fish health
- GIS

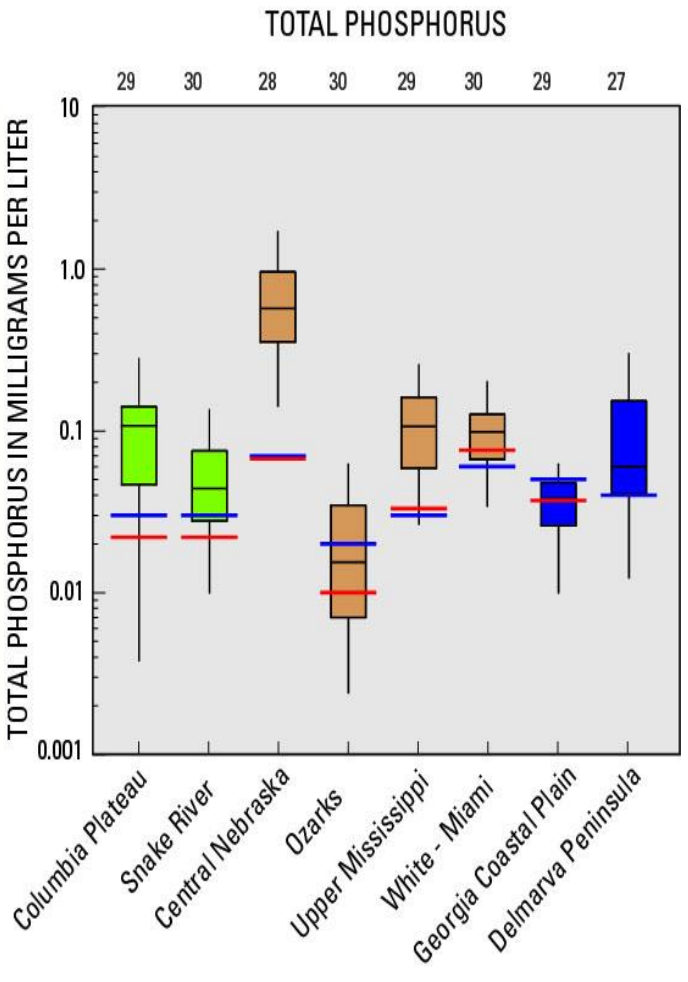


U.S. EPA Expert Workshop: Nutrient Enrichment Indicators in Streams (April 2013)

- Nutrients: TN and TP
- Primary producers: Chl-a, percent macrophyte cover, algal assemblages
- Ecosystem function: Continuous DO (heterotrophic and autotrophic responses)

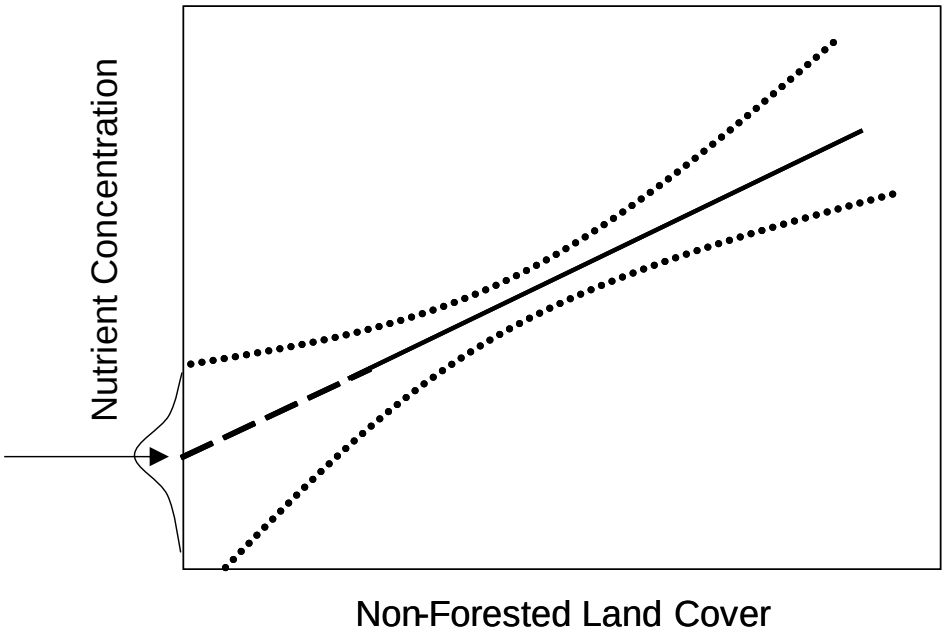
TN and TP concentrations





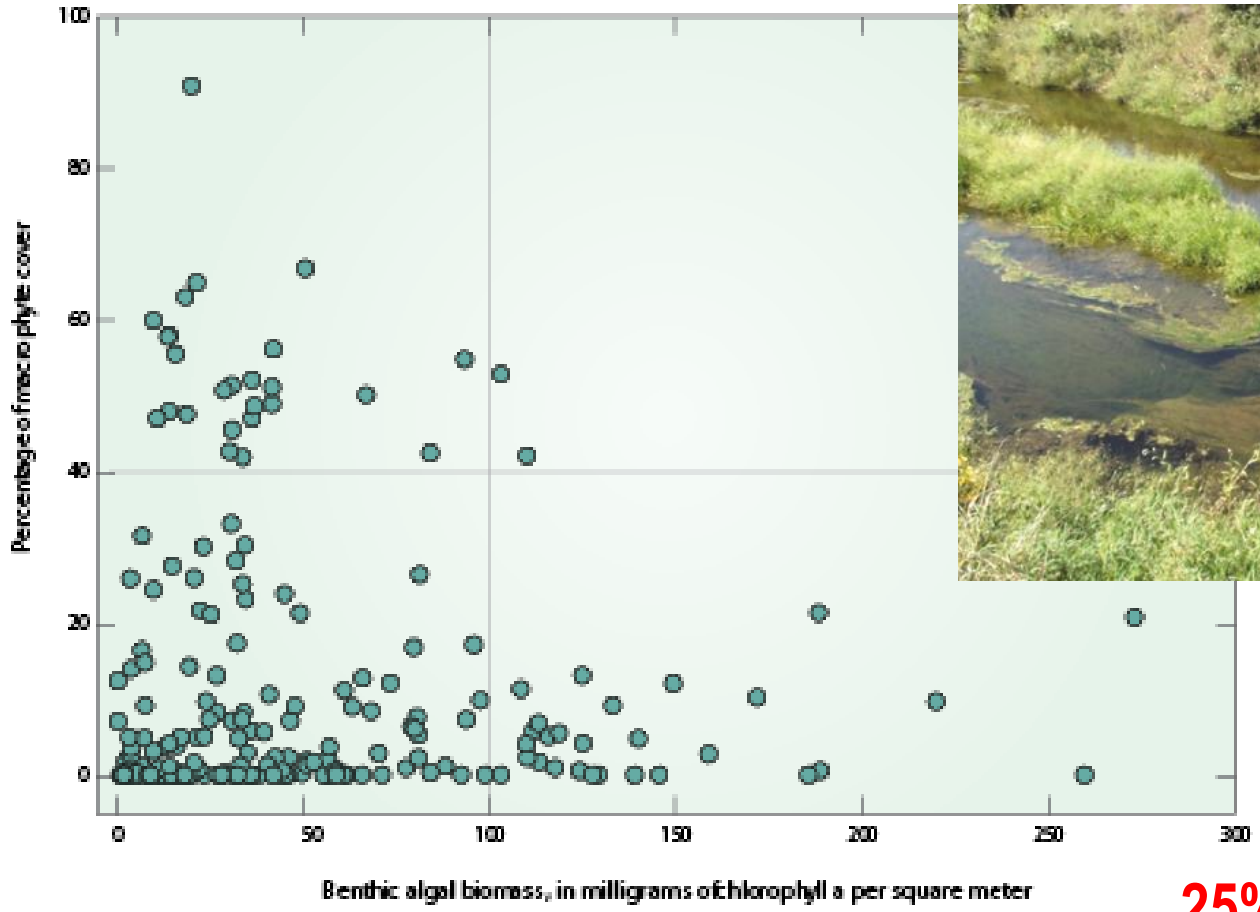
General Approach: Reference

- Modeling Reference
  - Model the reference condition based on disturbance



PIEDMONT TN MODEL
LogTN = 0.1 + 0.49*Agriculture + 0.14*Urban
$TN = 10^{0.1} = 1.0$ mg/L

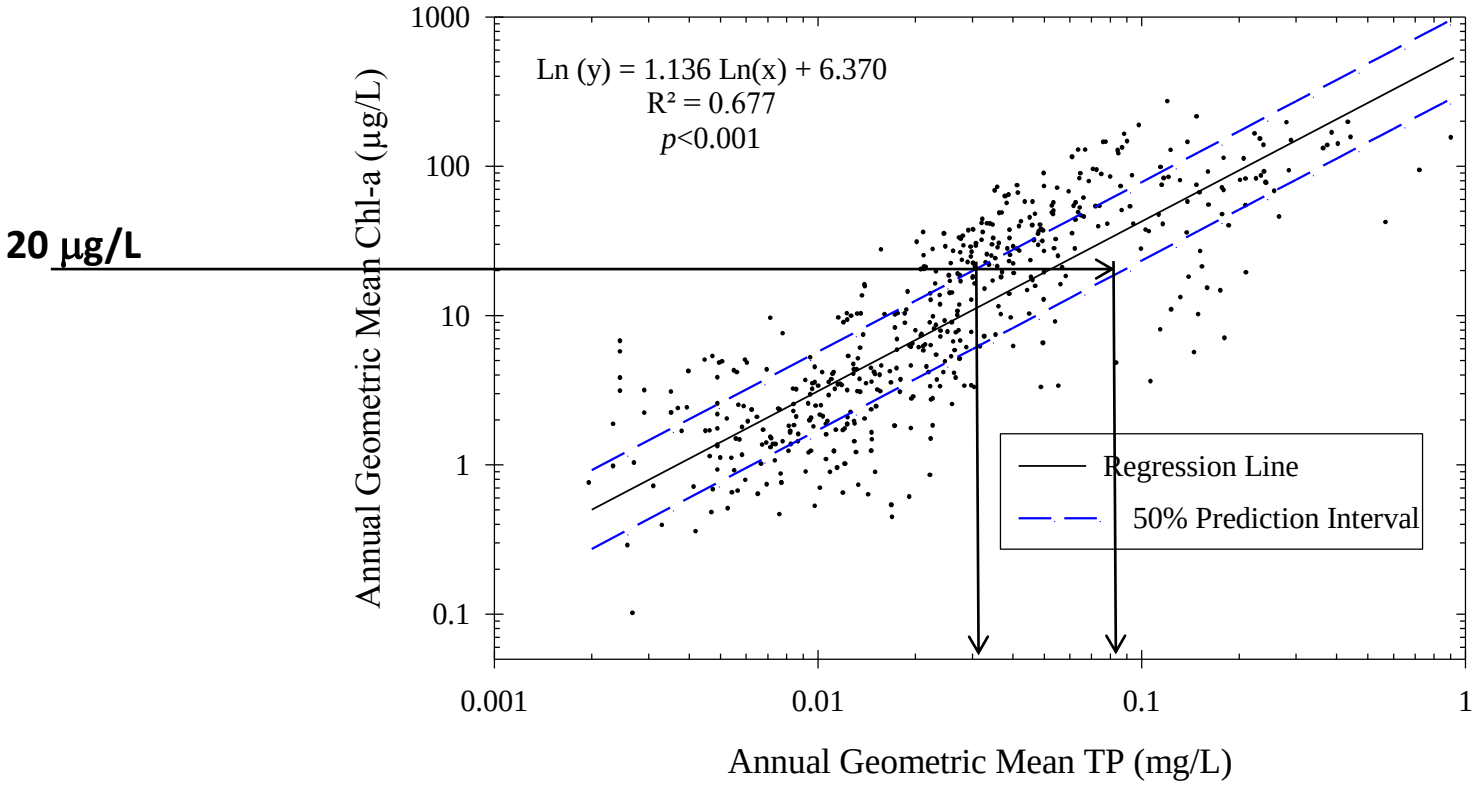
Primary producers: benthic algal biomass and macrophyte cover



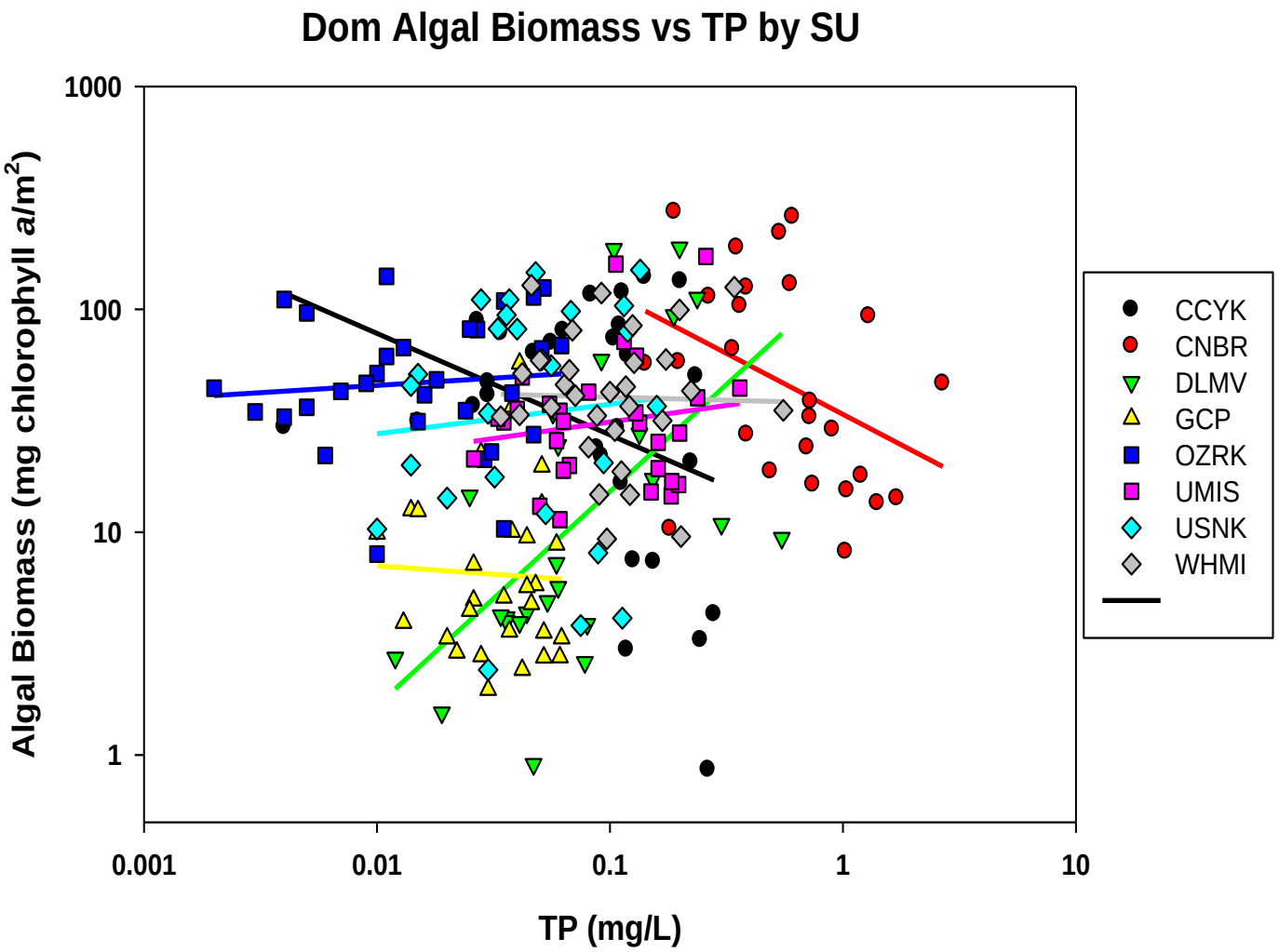
25% canopy is key

General Approach: Stressor-response

- Empirical Modeling



While increases in TN and TP are often associated with increased algal biomass, the relationship is often weak and varies regionally.



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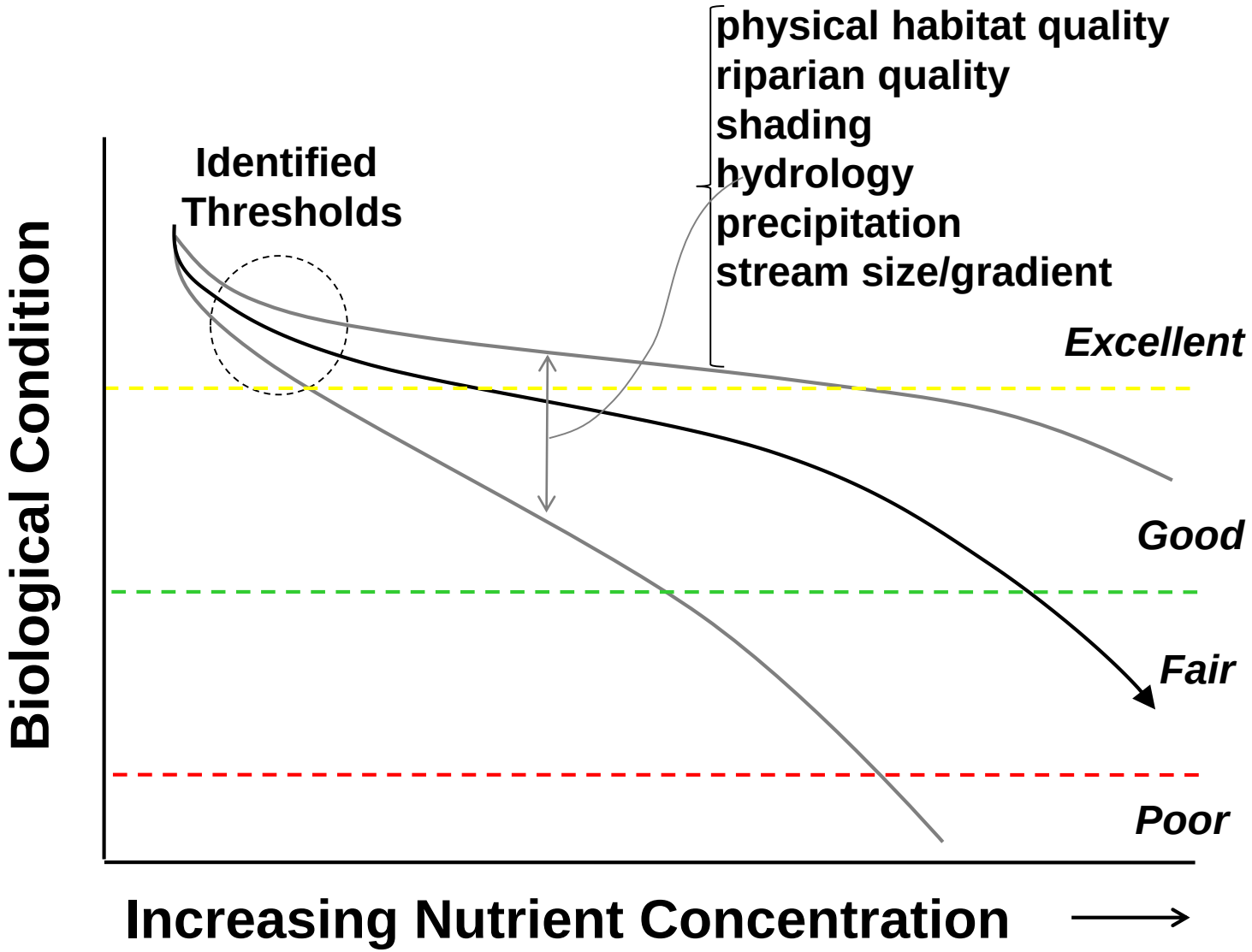
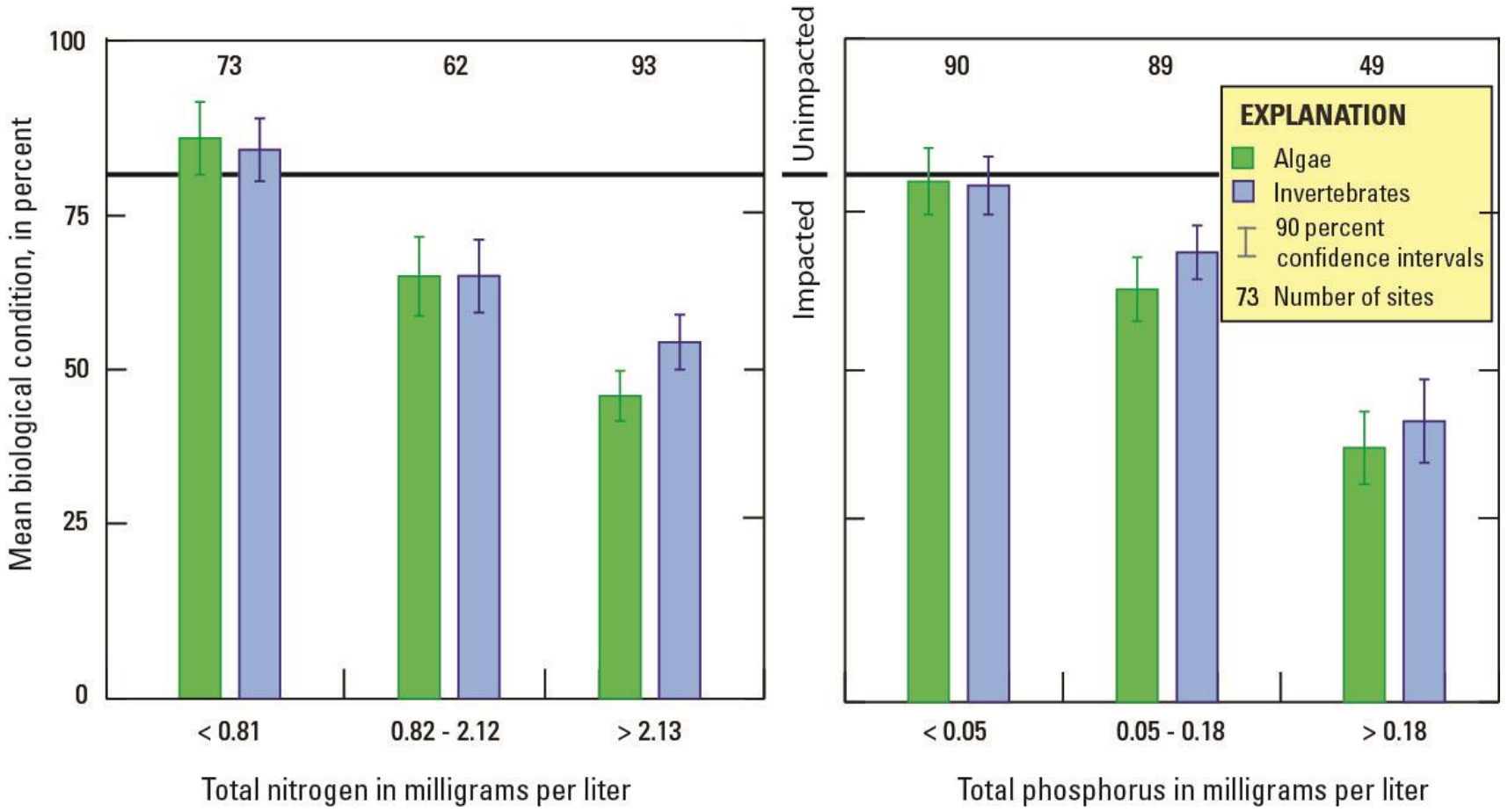
Munn et al. 2010

Biological Condition and Nutrient Concentration

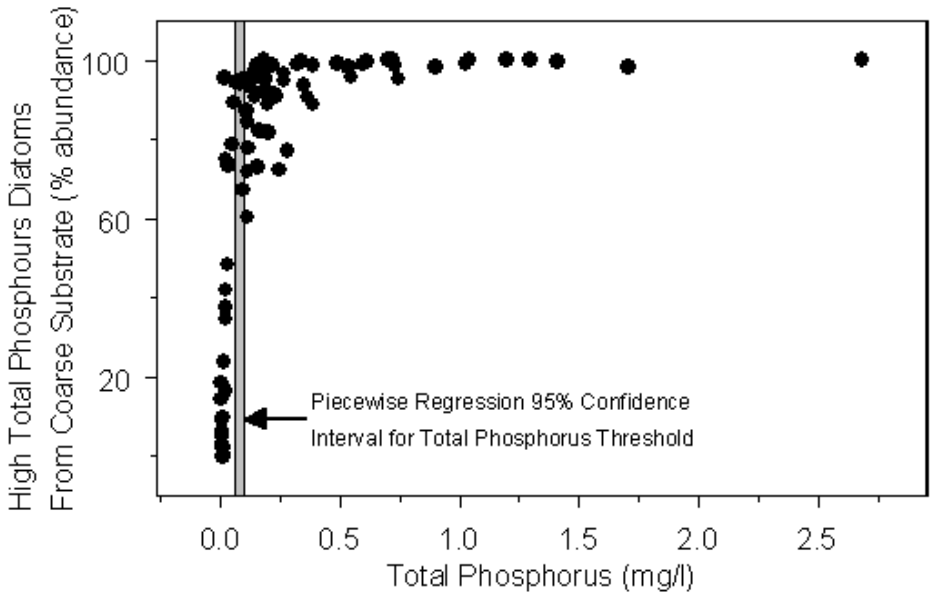


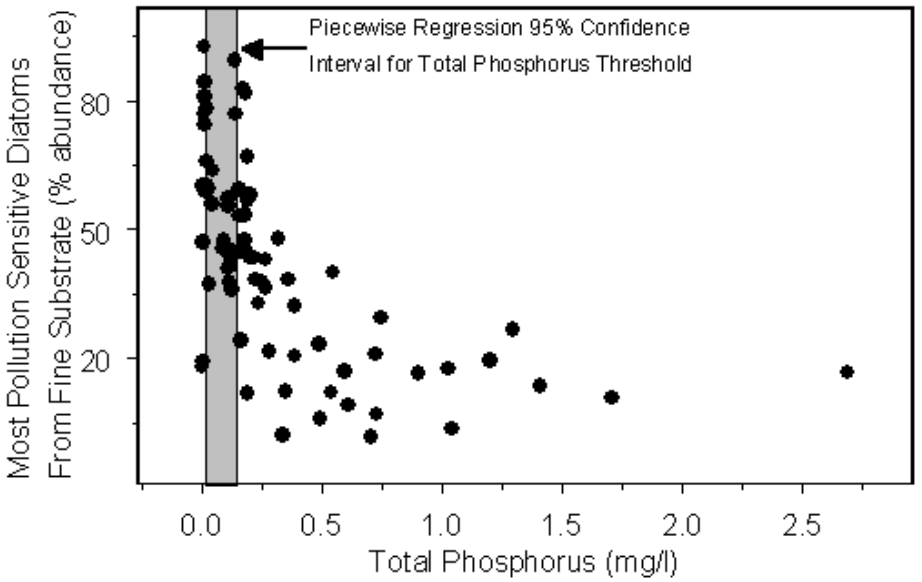
The Biological Condition in streams decreases with increased nutrients



Thresholds of response occur at low levels

- TP = 0.03 mg/L
- TN = 0.4 mg/L





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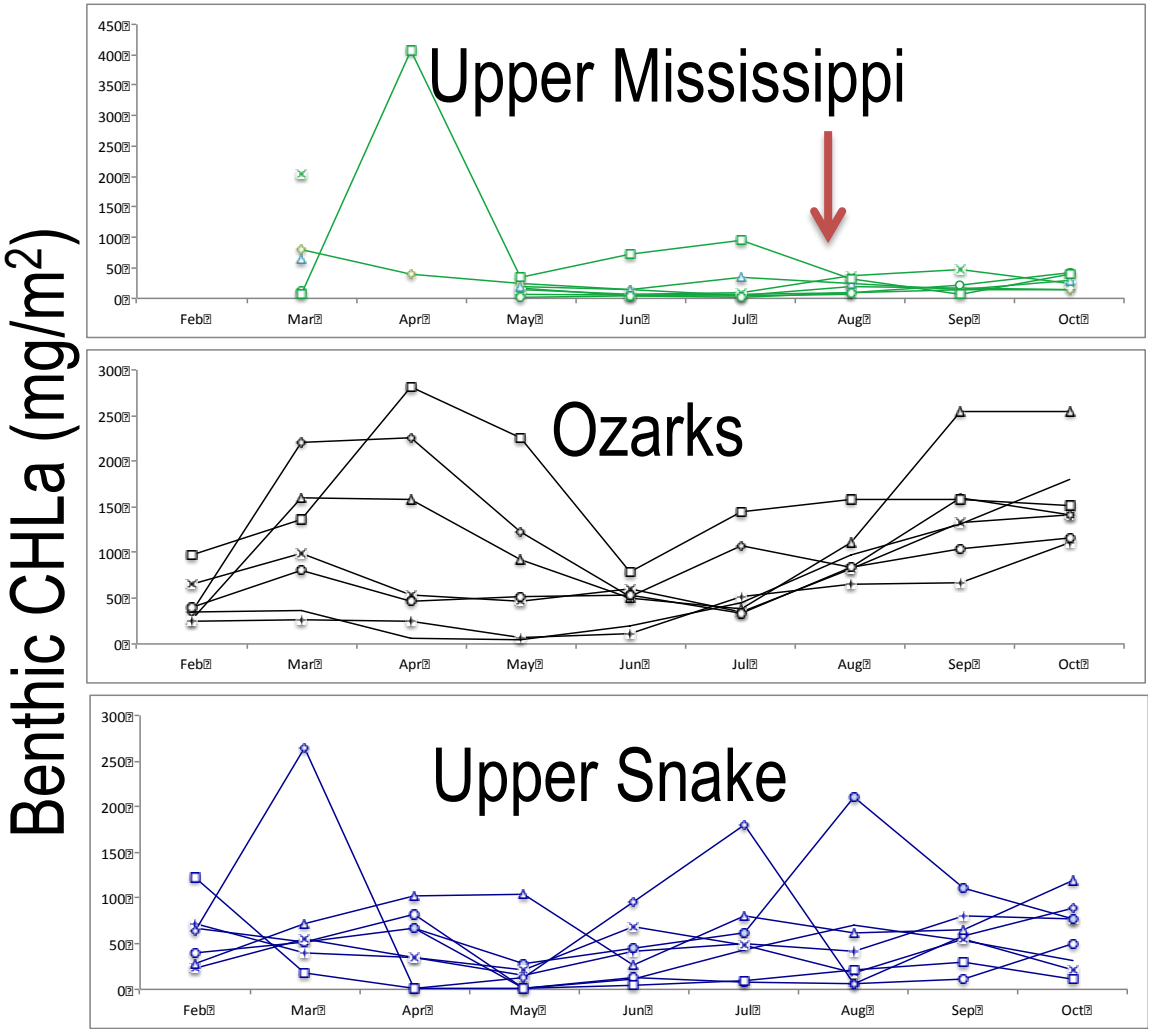
Continuous WQ monitoring

- Six of 88 sites, YSI and SUNA (nitrate)
- March to October
- Monthly nutrient, habitat, light, and benthic algal biomass and macrophyte cover

Peak algal biomass may not occur when you sample



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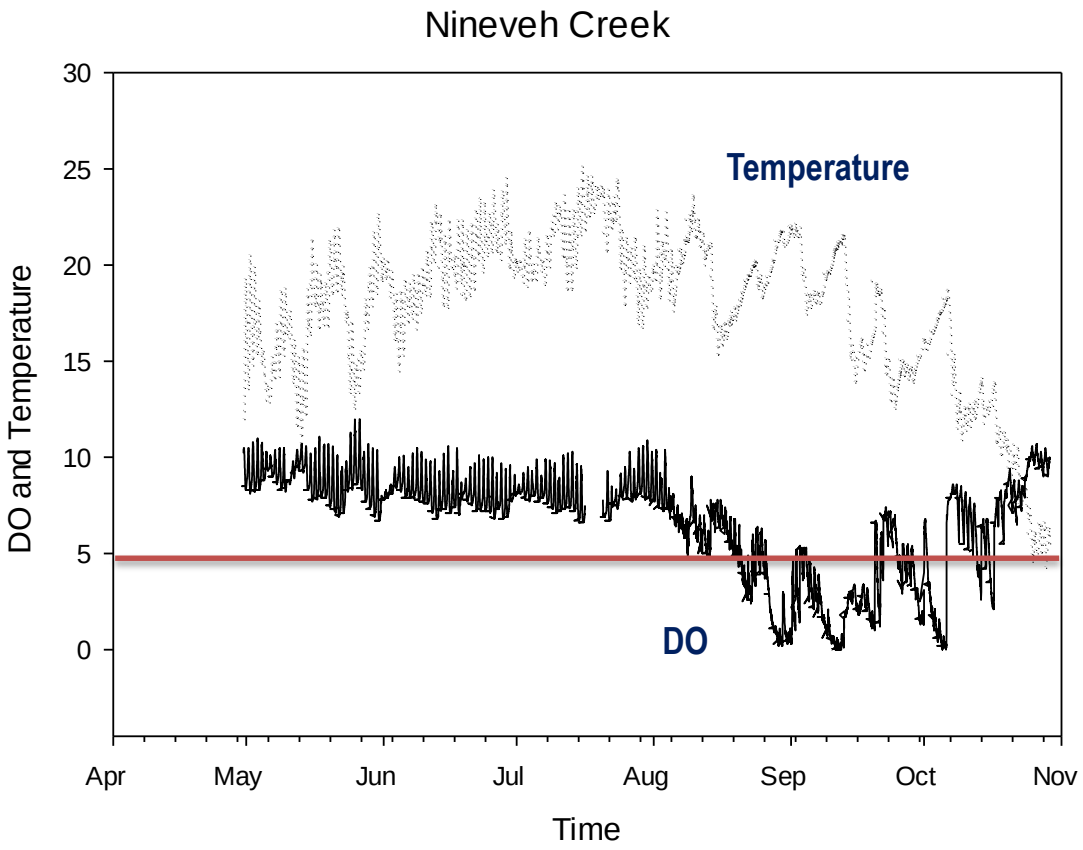
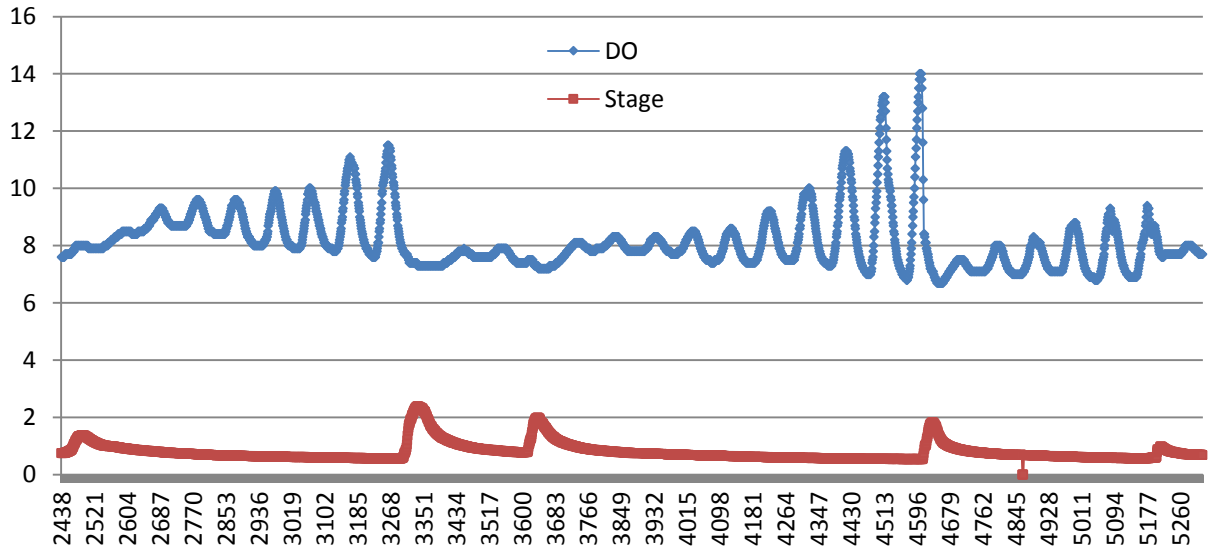
Dissolved oxygen and biological condition

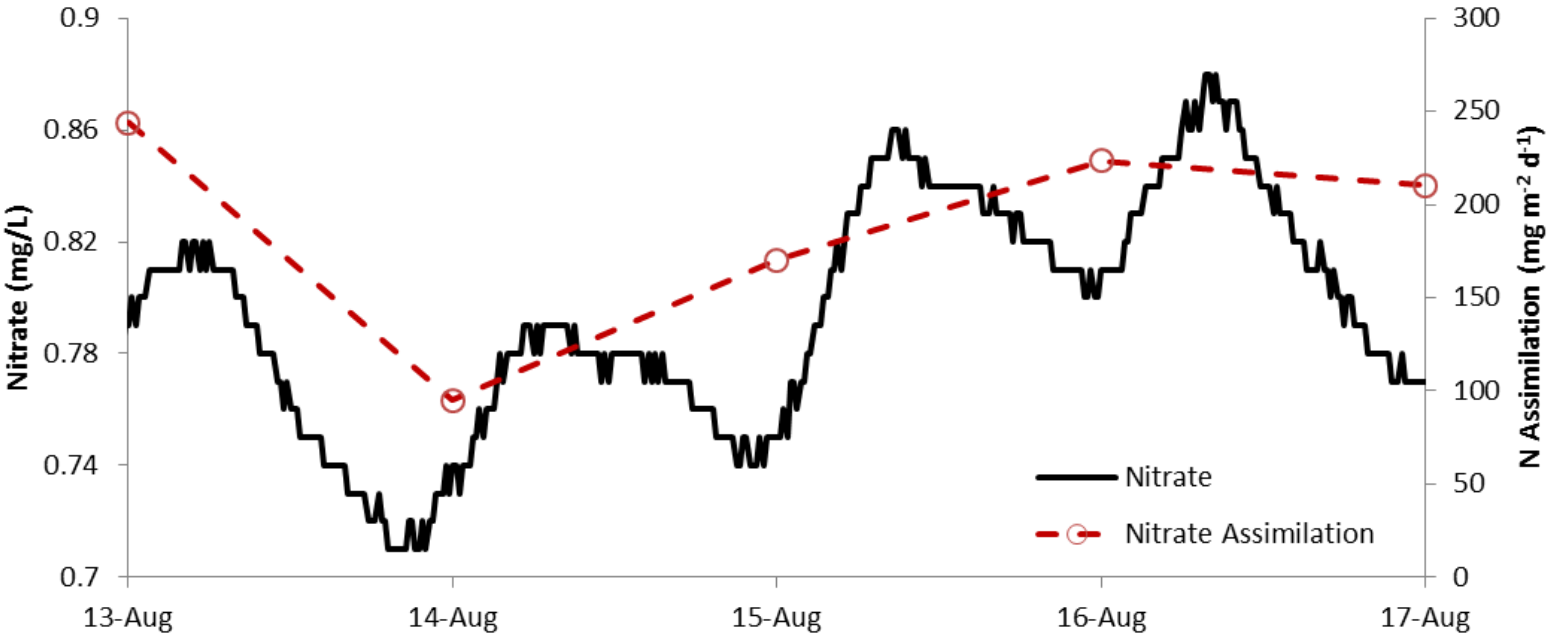


NEET: Invertebrate biological condition decreased by 50% in streams where dissolved oxygen fell below 5 mg/L (n=46).

The accrual (colonization plus growth) of benthic algal biomass is a function of nutrients, light, and temperature, whereas hydrologic stability and grazing control the process of biomass loss (Biggs 1996).



N Assimilation Rates – Eagle Creek at Zionsville



Daily N assimilation rates can be calculated during baseflow conditions

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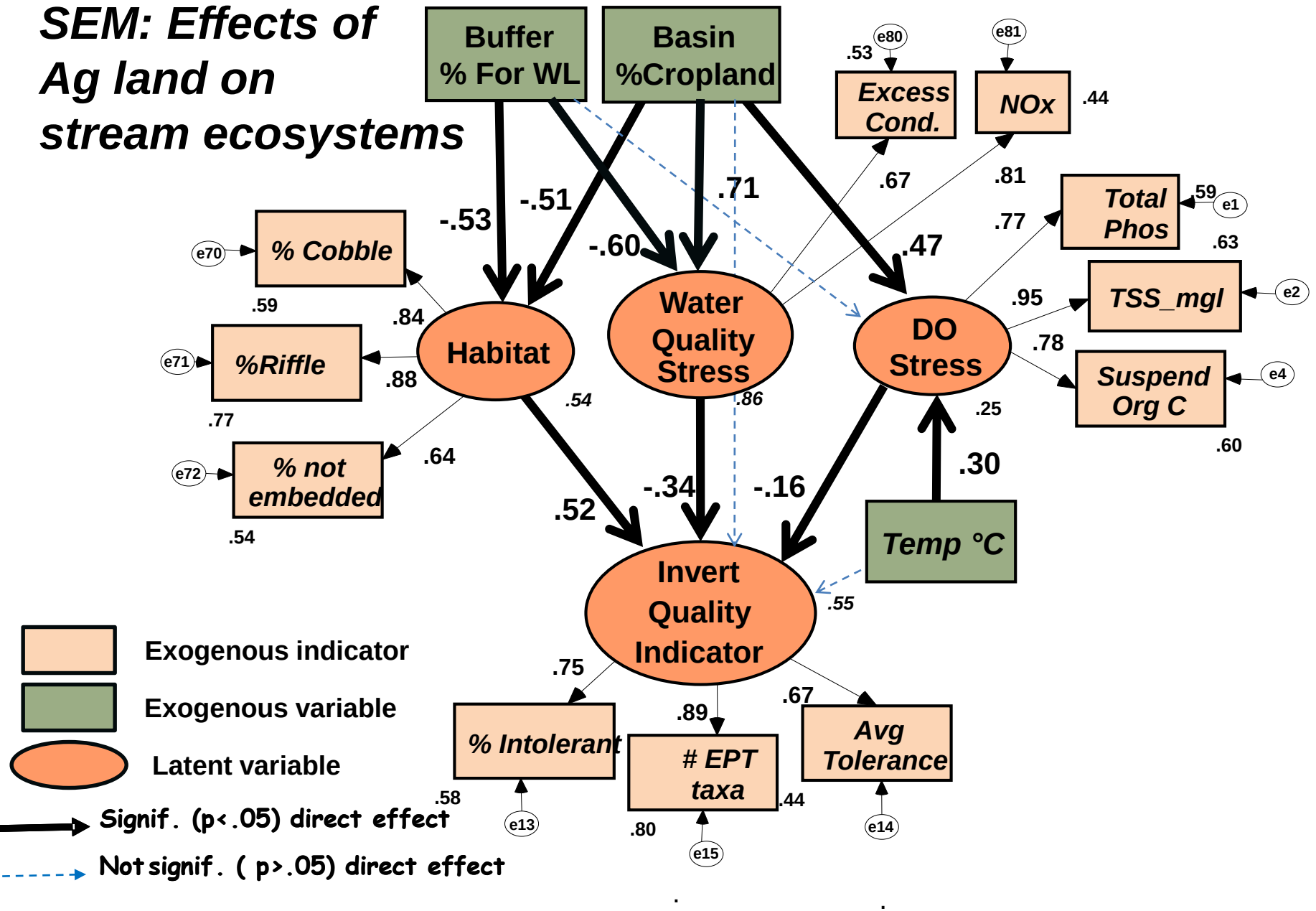
SEM: Effects of Ag land on stream ecosystems



Recommendations

- Regionalize: sites that span low to high nutrients
- Biological response better than nutrients alone
- Stressor variables: Nutrients and habitat (temp. and flow)
- Response variables:
  - Primary producers (benthic chlorophyll and macrophyte cover, algal assemblages)
  - Ecosystem function (Continuous DO)
  - Invertebrates can be useful, fish less so.
- Large spatial n for synoptic, but include nested temporal sites

General Approach: Classification

- Classification
  - Apples and Oranges
  - Separate waterbodies into ones expected to exhibit similar nutrient dynamics and biological responses in the absence of human impacts
    - *A priori*
      - Flow, climate, geology, hydrology
      - Ecoregions, physiographic provinces
    - *A posteriori*
      - Analyze nutrient/response dynamics in reference sites across landscape
  - For TMDLs, important to know that this is factored into target development, may not be necessary for a single waterbody

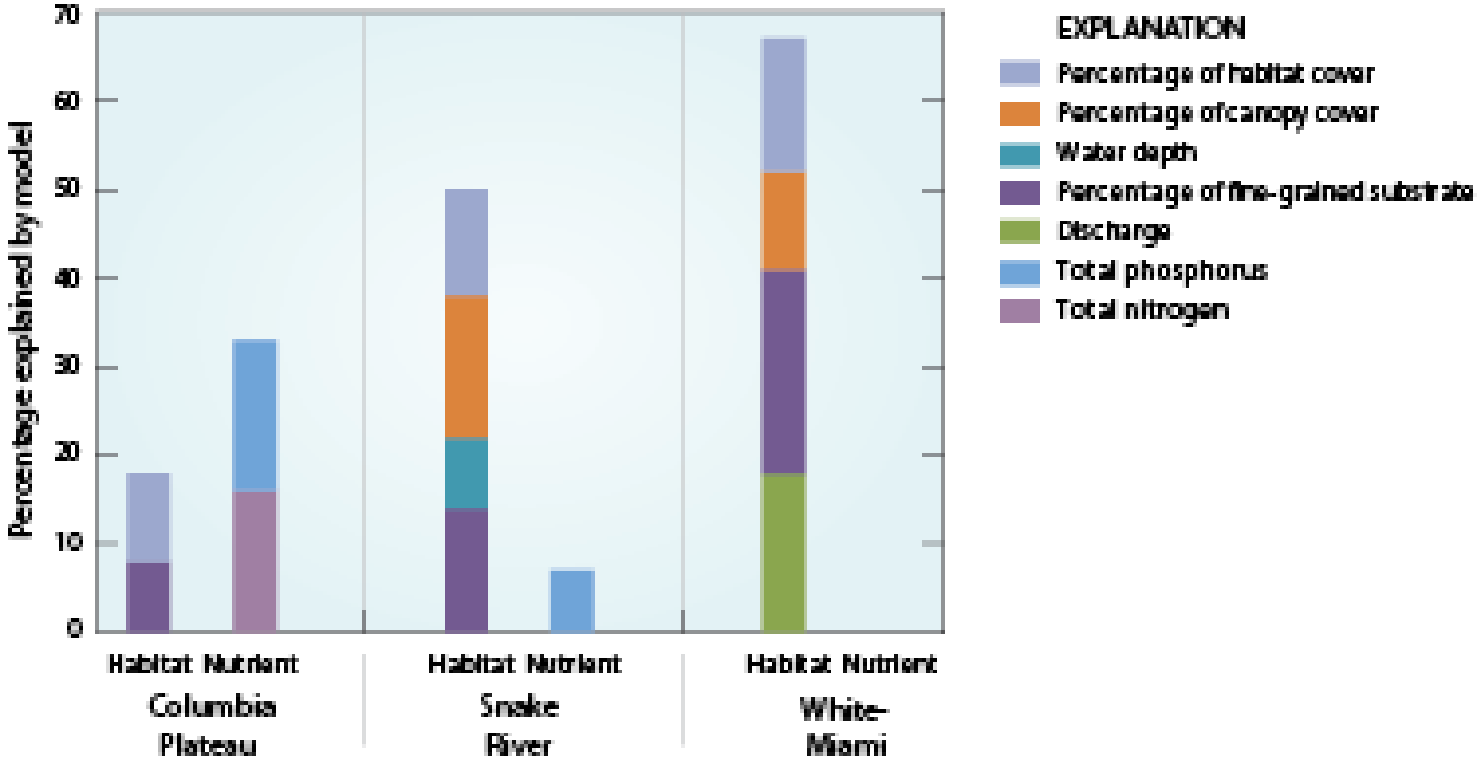
Complementary Approaches: Setting Targets

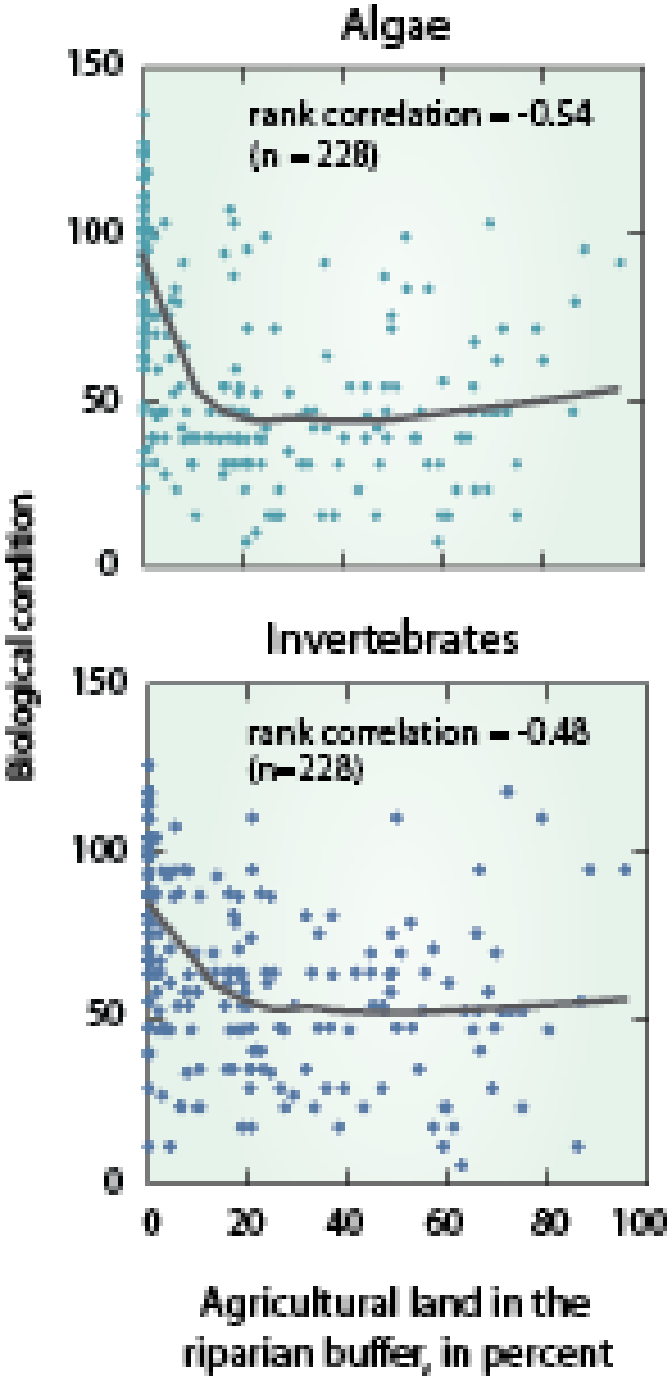
- TMDL Guidance
  - Reference
  - User surveys
  - Trophic classification
  - Literature
  - BPJ
- All of these are elements of Criteria Guidance

- Nutrient Criteria Guidance
  - Classification
  - Reference Condition Approaches
  - Stressor-Response Approaches
  - Scientific Literature and Expert Judgment
  - Mechanistic Models
  - Multiple Lines of Evidence
- Some of these under TMDL Guidance
- Multiple uses

General Approach: Mechanistic Models

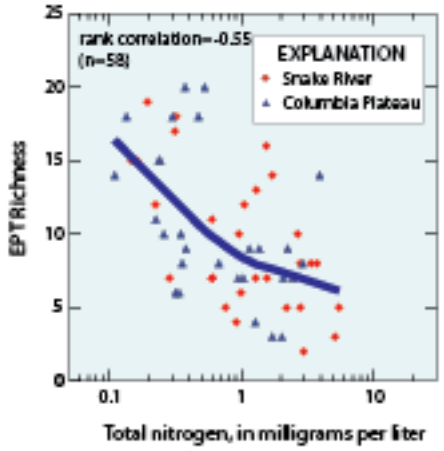
- Mechanistic and/or Process Models
  - E.g., WASP, QUAL-2k, EFDC, CE-QUAL, HSPF, MIKE…
  - Model specific endpoints to generate nutrient goals
  - Still need a desired endpoint for something…kicking the can, again
    - Primarily chemical endpoints (DO, clarity, pH), some biological endpoints (Chl a, some species)
    - AQUATOX can do ecological endpoints
    - Run these to back out nutrient concentrations/loads to meet response endpoint
  - Site specific application has limited the utility for regional criteria

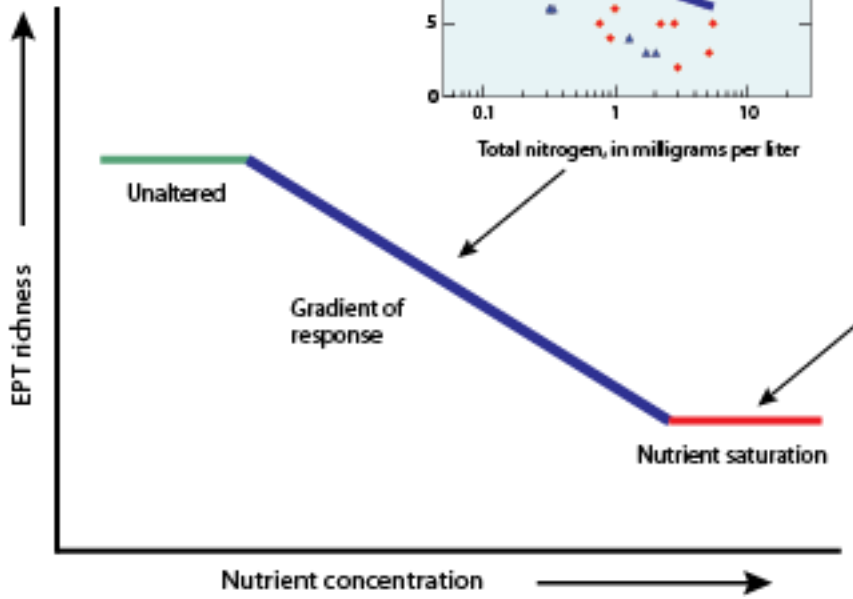

Percentage explained by model
70
60
50
40
30
20
10
0
Habitat Nutrient
Columbia Plateau
Habitat Nutrient
Snake River
Habitat Nutrient
White-Miami
EXPLANATION
Percentage of habitat cover
Percentage of canopy cover
Water depth
Percentage of fine-grained substrate
Discharge
Total phosphorus
Total nitrogen


Algae
rank correlation = -0.54
(n = 228)
Invertebrates
rank correlation = -0.48
(n=228)
Biological condition
150
100
50
0
0
20
40
60
80
100
Agricultural land in the
riparian buffer, in percent

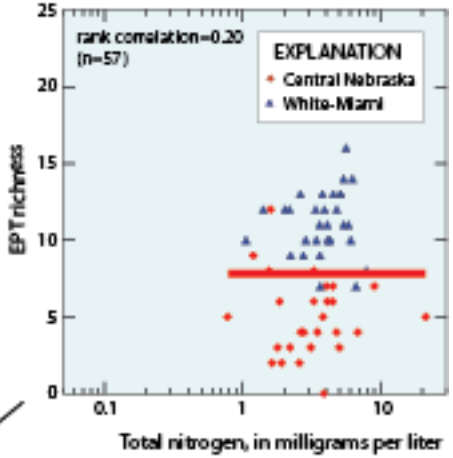
Response patterns of EPT richness to nutrient enrichment

Regions with a sufficient nutrient gradient can provide States the opportunity to derive nutrient criteria by measuring biological responses.





Trend lines are locally weighted scatterplot smoothing



The higher overall EPT richness for the White-Miami sites suggest other environmental factors besides nutrients are important.

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